# AND9165/D

# Getting Started with Power Line Communication

**ON Semiconductor®**

## APPLICATION NOTE

**Introduction**

ON Semiconductor has developed a power line communication (PLC) solution for metering and machine-to-machine applications with spread frequency shift keying (S–FSK).

This application note describes how to get started with power line communication using the NCN49597 and NCN49599 modems. It proposes five steps towards an end product: choosing a modem and firmware (sections 1 and 2), selecting an evaluation kit (section 3), building a prototype (section 4) and writing application software (section 5).

Only an overview is given below; detailed information is available in [5, 6, 7, 8].

## 1 SELECTING A PRODUCT

ON Semiconductor currently offers the NCN49597 and NCN49599 as successors of the highly successful AMIS–49587 PLC modem[1].

Both are single chip half duplex S–FSK modems designed for hostile communication environments with very low signal-to-noise ratio (SNR) and high interference. Together with firmware, they handle the lower layers of communication protocols. Because the lower layers are handled on-chip, the user can concentrate on the higher application layers resulting in faster development.

The NCN49597 and NCN49599 are functionally identical expect that the latter integrates a power operational amplifier (opamp). The opamp can be used as a line driver; it is also available as a separate part, NCS5651, which is recommended for use with the NCN49597.

The NCN49599 is well-suited for cost-sensitive applications; the NCN49597 is recommended for concentrator and multi-phase applications[2].

The modem communicates with the user over a serial interface. Firmware must be loaded immediately after reset. This may be done over the serial interface; alternatively, the modem can autonomously retrieve the firmware from an attached SPI memory. For more information, refer to [6, "Boot loader"].

## 2 FIRMWARE

ON Semiconductor offers a royalty–free firmware solution called ON–PL110.

It implements a mesh network topology based on a proprietary extention of the KNX PL110 specification [4]. Typical applications are smart grid home and building automation, solar panel control, lighting and industrial control, and split metering.

The firmware provides both the physical (PHY) layer and media access control (MAC) layer,[3] reducing the implementation effort for the user.

The ON–PL110 stack features hierarchical addressing, collision avoidance, error–repairing block coding and dual channel operation. In addition, communication is possible on both AC and DC grids.

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[1] This modem and its predecessor, the AMIS–30585, are still available but not prefered for new designs. They can not be reprogrammed and only support the firmware embedded in the integrated read-only memory.

[2] More information may be found in [5, "Multi-phase designs"].

[3] Any layer can be selected as the top layer; the higher layers (if any) are automatically disabled. This allows application tailored protocols.

[4] In the context of metering applications, the master is a concentrator (or "client" in the IEC terminology) and the slaves are electricity meters ("servers"). Typically, a concentrator controls 100–200 meters.

Figure 1. Contents of a PLC Evaluation Kit



Figure 2. Evaluation Board: Motherboard and
Plugged-on Daughterboard

## 3 SELECTING AN EVALUATION KIT

Evaluation kits (EVKs) are available for the NCN49597 and NCN49599; a kit contains two motherboards and two daughterboards (Figures 1 and 2), allowing the user to set up communication quickly. For more details, refer to [5].

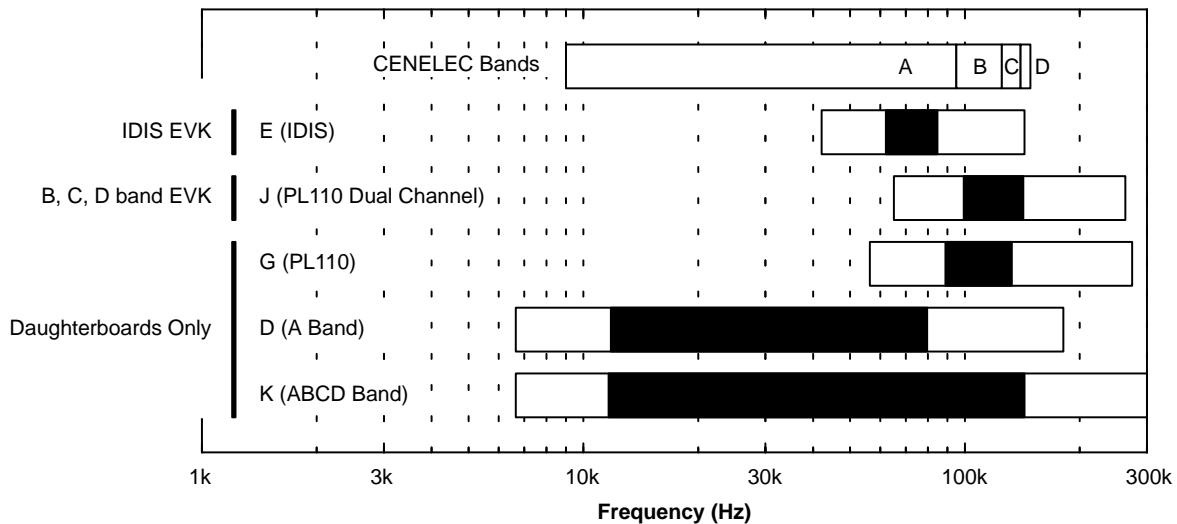The EVKs are provided in two variants with different receive and transmit filters (Figure 3).



Figure 3. Daughterboard and evaluation kits are available for various frequency ranges.
The –1 dB bandwidth of the receive filter is shown in black for each daughterboard, indicating the optimal
carrier frequency range. The –10 dB bandwidth is also shown (white).

The first EVK variant is optimised for the widely used IDIS[5] carrier frequencies (63.3 kHz and 74.5 kHz). In most countries these frequencies are reserved for utility companies; therefore this EVK is available only upon special request.

The second EVK variant covers the B, C and D band, i.e. 95–148.5 kHz ("J" daughterboards).

If you wish to communicate on other frequencies it is recommended to order "D" or "K" daughterboards together with the evaluation kit.

Separately, daughterboards are available covering the CENELEC A band (9–95 kHz; "D" daughterboards), all CENELEC bands (9–148.5 kHz; "K") and the PL110 frequencies 105 kHz and 115 kHz ("G").

The usual lead time is three weeks. To receive a quote, please contact your sales representative and specify the orderable part number (OPN) from Table 1 and your prefered distributor. Please also specify your target application so that we can assist you better.

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[5] IDIS is a specification for smart meters defined by the Interoperable Device Interface Specifications (IDIS) Industry Association.

## 4 BUILDING A PROTOTYPE

Before a final application printed circuit board (PCB) is designed, it usually makes sense to build a prototype. This reduces risk and allows rapid software development and evaluation.

An evaluation board can readily be used as a development platform. During normal operation a computer controls the modem over a USB connection. However, a user microcontroller can be connected easily, replacing this connection and assuming control (Figure 4). For more information, refer to [5].

**Table 1. ORDERABLE PART NUMBERS (OPN) OF THE PLC EVALUATION KITS AND DAUGHTERBOARDS**

| | | Product | |
|---|---|---|---|
| | Carrier Frequencies [kHz] | **NCN49597** | **NCN49599** |
| EVK | E: 63.3 & 74.5<br>J: 95−150 | NCN49597ID11GEVK<br>NCN49597PD11GEVK | NCN49599ID11GEVK<br>NCN49599PD11GEVK |
| Daughterboard | D: 9−95<br>K: 9−150<br>G: 105 & 115 | NCN49597DBD1GEVB<br>NCN49597DBK1GEVB<br>NCN49597DBG1GEVB | NCN49599DBG1GEVB<br>NCN49599DBG2GEVB* |

*Low−cost variant; 6 weeks lead time; 25 pieces minimum ordering quantity.
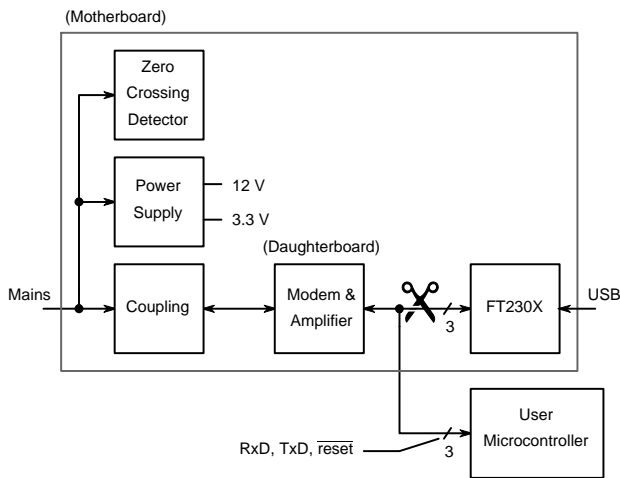


**Figure 4. Building a Prototype with an EVK**

It is also possible to incorporate daughterboards in a prototype. ON Semiconductor can supply tested daughterboards at-cost for low volume pilot deployments, saving considerable development effort and ensuring a short time-to-market.

To reduce cost and board size a low−cost variant of the NCN49599 daughter board is available (NCN49599DBG2GEVB). Refer to [9] for more information. A minimum ordering quantity of 25 applies for this variant.

## 5 WRITING APPLICATION SOFTWARE

In a typical application, the modem is controlled by an external microcontroller.

ON Semiconductor provides extensive support for developing the firmware of this microcontroller. We can provide documentation demonstrating how to configure the modem by means of management information base (MIB) get and set operations, and how to order the modem to transmit packets.

Reference firmware[6] for Cortex−M3 microcontrollers will be published in the near future. The source code is easily ported to other microcontrollers.

The modem firmware provides ample support to assess the PLC link quality, including in-band signal statistics reporting. As a result, debugging is simplified and a faster development pace is assured.

Note that the modem firmware is delivered as a binary only; modifying the code and adding application functionality is not possible.

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[6] This implementation is provided without warranty and for illustration purposes only. Contact your sales representative for more information and to obtain a copy of the source code.

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## REFERENCES

[1] Èlectricité réseau distribution France, ERDF. Linky PLC profile functional specification, September 2009. Online at http://www.erdfdistribution.fr/medias/Linky/ERDF−CPT−Linky−SPEC−FONC−CPL.pdf, accessed 2014−02−20.

[2] IEC. Automatisation de la distribution à l'aide de systèmes de communication à courants porteurs – partie 4: Protocoles de communication de données – Section 32: Couche liaison de données – Contrôle de liaison logique (LLC), September 1996.

[3] IEC. Automatisation de la distribution à l'aide de systèmes de communication à courants porteurs – Partie 5−1: Profils des couches basses, May 2001.

[4] KNX Association. KNX powerline PL 110 basic course, April 2013.

[5] ON Semiconductor. Evaluation kit for power-line communication user manual (preview), December 2014.

[6] ON Semiconductor. NCN49597 power line carrier modem datasheet, December 2014. Online at http://www.onsemi.com/pub_link/Collateral/NCN49597−D.PDF.

[7] ON Semiconductor. NCN49599 power line carrier modem datasheet, December 2014. Online at http://www.onsemi.com/pub_link/Collateral/NCN49599−D.PDF.

[8] ON Semiconductor. PLC ESW and EVK selection guide (application note), October 2013.

[9] Pierre Woestyn and Peter Cox. *PLC evaluation boards enable rapid in−home display prototyping* (application note). ON Semiconductor, April 2016.